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<b>(21) International Application Number:</b> PCT/GB90/01830 <b>(22) International Filing Date:</b> 26 November 1990 (26.11.90)  <b>(30) Priority data:</b> 8926739.7 27 November 1989 (27.11.89) GB  <b>(71) Applicants (for all designated States except US):</b> DE LA RUE SYSTEMS LIMITED [GB/GB]; De La Rue House, 3/5 Burlington Gardens, London W1A 1DL (GB). THE QUANTUM FUND LIMITED [GB/GB]; 16 Buccleuch Place, Edinburgh EH8 9LN (GB).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only) :</b> BROTHERSTON, Colin, Peter [GB/GB]; 7 Helston Drive, Emsworth, Hampshire PO10 7TP (GB). DENYER, Peter, Brian [GB/GB]; 91 Collinton Road, Edinburgh EH10 5DF (GB).		<b>(74) Agent:</b> GILL JENNINGS & EVERY; 53-64 Chancery Lane, London WC2A 1HN (GB).  <b>(81) Designated States:</b> AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> IMPROVEMENTS RELATING TO VERIFICATION OR AUTHENTICATION PROCESSES  <b>(57) Abstract</b>  A method of updating reference biometric data characteristic of an individual for use in a verification or authentication process in which process the relationship between the currently measured biometric data and the reference biometric data is determined. The method comprises monitoring the acceptability of the relationship determined during a number of verification or authentication processes; and if a number N (e.g. 3) of the relationships over a number M (e.g. 8) of verification or authentication processes is unacceptable, updating the reference biometric data with more recently obtained biometric data.		

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IMPROVEMENTS RELATING TO VERIFICATION  
OR AUTHENTICATION PROCESSES

5       The invention relates to a method of updating reference biometric data characteristic of an individual for use in a verification or authentication process in which process the relationship between currently measured biometric data and the reference biometric data is determined.

10       It is becoming common to make use of biometric data to verify or authenticate an individual prior to permitting that individual to take part in a transfer of value transaction, gain access to a building and the like. Biometric data defines one or more physical or behavioural  
15       characteristics of the individual and includes signature, voice and fingerprint data and the like. In a conventional verification or authentication process, an individual is initially enrolled during which reference biometric data is obtained (possibly by averaging a number of samples) and  
20       then during subsequent verification or authentication processes, this reference data is compared with currently measured biometric data. For example, a value may be generated defining the difference between two sets of data and this value is then compared with a threshold. If the  
25       value is greater than the threshold then the individual is not verified or authenticated but otherwise authentication is achieved.

      One of the problems with the conventional system is the manner in which initial enrolment is performed.  
30       Generally, a number of sets of biometric data have to be supplied which are then processed to form a final reference data set.

      Furthermore it has been the practice in a number of identification systems to continually update the reference  
35       biometric data whenever a successful identification occurs. Thus, as soon as an individual passes the required verification or authentication requirements, the reference

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biometric data is replaced by the currently measured biometric data.

In accordance with the present invention, a method of updating reference biometric data characteristic of an individual for use in a verification or authentication process in which process the relationship between the currently measured biometric data and the reference biometric data is determined comprises monitoring the acceptability of the relationship determined during a number of verification or authentication processes; and if a number N of the relationships over a number M of verification or authentication processes is unacceptable, updating the reference biometric data with more recently obtained biometric data.

We have devised a method which allows a very simple enrolment process, generally the supply of a single set of biometric data, but which updates that reference data depending upon the performance of the individual during subsequent verification or authentication processes. It should be noted, in contrast, that previous updating techniques have not monitored the performance of the user but have simply placed the reference data on every occasion of a successful identification. Our method also reduces the need for formal reenrolment in the case of poor performance.

A problem with biometric characteristics is that these can vary due to damage, variations in temperature and variations in the manner in which the parameter is presented by the individual. Consequently, verification or authentication processes generally define a tolerance band within which a current biometric measure must fall. This tolerance band is defined by the initial reference data. A balance has to be drawn, however, between making

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the band too narrow so as to produce a number of false acceptances and making the band broad enough to reduce the number of false rejections. This balance can vary depending upon the sensitivity of the activity to which the individual is to be permitted access.

A problem with these conventional updating methods is that where currently measured or bid biometric data fall close to the limit of a tolerance band then this will be used to update the reference biometric data thus running the risk that the quality of this reference data will be degraded by being over written by marginal bid data.

Preferably therefore in order to overcome this problem, the more recently obtained biometric data which is used to update the reference biometric data is selected from biometric data which satisfies predetermined conditions defining a better degree of acceptability than is essential to pass the verification or authentication process.

For example, where the relationship used in the verification or authentication process is a tolerance band within which the currently measured biometric data must fall, the predetermined conditions may define a narrower tolerance band.

In other examples, in which a comparison score is generated defining the relationship between the currently measured and reference biometric data, only currently measured biometric data which has a score exceeding a threshold is used to update the reference biometric data.

In further examples, the condition of the currently measured biometric data is monitored, the predetermined conditions defining a condition of the currently measured biometric data exceeding a threshold. For example, in the case of fingerprint verification, an image of the fingerprint is formed by contact between the finger and a

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platen. The platen is typically made of a polymer material to improve the optical contact of the skin. The brightness of the image is caused by a good (high area) optical contact. In this system - contact causes  
5 brightness. Poor contact may occur due to

- 1) Insufficient application pressure.
- 2) Dry skin.

The optical sensor in the unit (CCD imager) recognises the brightness as a voltage output. This output is  
10 digitised and filtered to produce a digital image.

If the brightness is low - the image becomes degraded and starts to be affected by noise - eg. background illumination effects which are always present in the system.

15 On a wider view - ie. applying re-enrolment to other non-optical biometric systems - brightness is synonymous with any sensor output - eg. sound, temperature.

Typically, the most recently obtained measured biometric data which satisfies the predetermined conditions  
20 will be used to update the reference biometric data.

In the preferred example, N is at least 3 and M is 8.

In some cases, the user's performance can be so poor that automatic updating of the reference data is insufficient to significantly improve his performance.  
25 Preferably therefore the method further comprises monitoring the performance of the user and providing an indication that reenrolment is advisable if the performance of the updating method satisfies predetermined conditions. These predetermined conditions may comprise the  
30 detection of at least P consecutive unacceptable relationships, or the performance of at least Q updating steps within R performances of the verification or authentication process.

In the preferred examples, P is 4, Q is 3 and R is 32.  
35

An example of a fingerprint verification process incorporating a method according to the invention will now

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be described with reference to the accompanying drawing which is a flow diagram of the method.

In this description it will be assumed that a conventional fingerprint detection apparatus is used for example of the type described in PCT/GB90/01270 the disclosure of which is incorporated herein by reference. It should be noted, however, that the present invention is applicable to all forms of biometric verification including signature, voice and the like.

Before the verification or authentication process can be used, a formal enrolment process is undergone. In this enrolment process, the user is requested to give a single fingerprint in the same fashion as for a normal or bid use. This is particularly attractive to the user since it minimises the time involved in enrolling but it has to be recognised that the enrolled image is significantly imperfect for approximately 20% of the user population. The present invention overcomes this problem by monitoring the performance of each user.

During a normal use, the user presents his finger to enable bid biometric data to be determined (step 1). This determination is performed in a conventional manner to generate a value or set of values which are then compared (step 2) with a corresponding reference set which initially has been obtained during the enrolment process. This comparison may involve determining the difference between two single values or, in the case of sets of values, determining the Euclidean distance between the sets. In another approach, the reference data can be used to set a tolerance band around the or each reference value and it is determined whether the corresponding bid values each fall within their respective tolerance bands.

Whether or not the comparison is successful, an unsuccessful bid count N is reviewed. This value N represents the number of unsuccessful bids in the last eight attempts. Thus, the last eight attempts including the most recent are reviewed and the count N adjusted to

indicate the number of unsuccessful attempts in those last eight (step 3).

5 If the latest bid is unsuccessful, for example because one or more of the bid values falls outside corresponding tolerance bands or the difference between the bid and reference data exceeds a predetermined threshold then the verification or authentication process may end although in some cases processing may return to step 1 to allow a further attempt to be processed. A limit may be  
10 set on the number of repeats permitted in a certain time interval.

If the bid is successful then verification will be indicated (step 4) allowing the user to perform the secure process to which he has gained access.

15 In addition, in the case of a successful bid, the count N is reviewed to see whether it is equal to or exceeds 3. If it is less than 3 then the process ends but if it is equal to or greater than 3 then the tolerance reference data is replaced with the most recently obtained  
20 bid data (step 5).

In certain circumstances, a user's performance may be so poor that this process will not be sufficient by itself to improve the performance. This may be detected if for example there are four or more consecutive unsuccessful  
25 bids or the reference data is replaced three or more times within a history of 32 attempts. In these cases, the user can be recommended to reenrol under supervision using a different finger. The recommendation contains the form of an audible or visual warning, repeated at every bid.

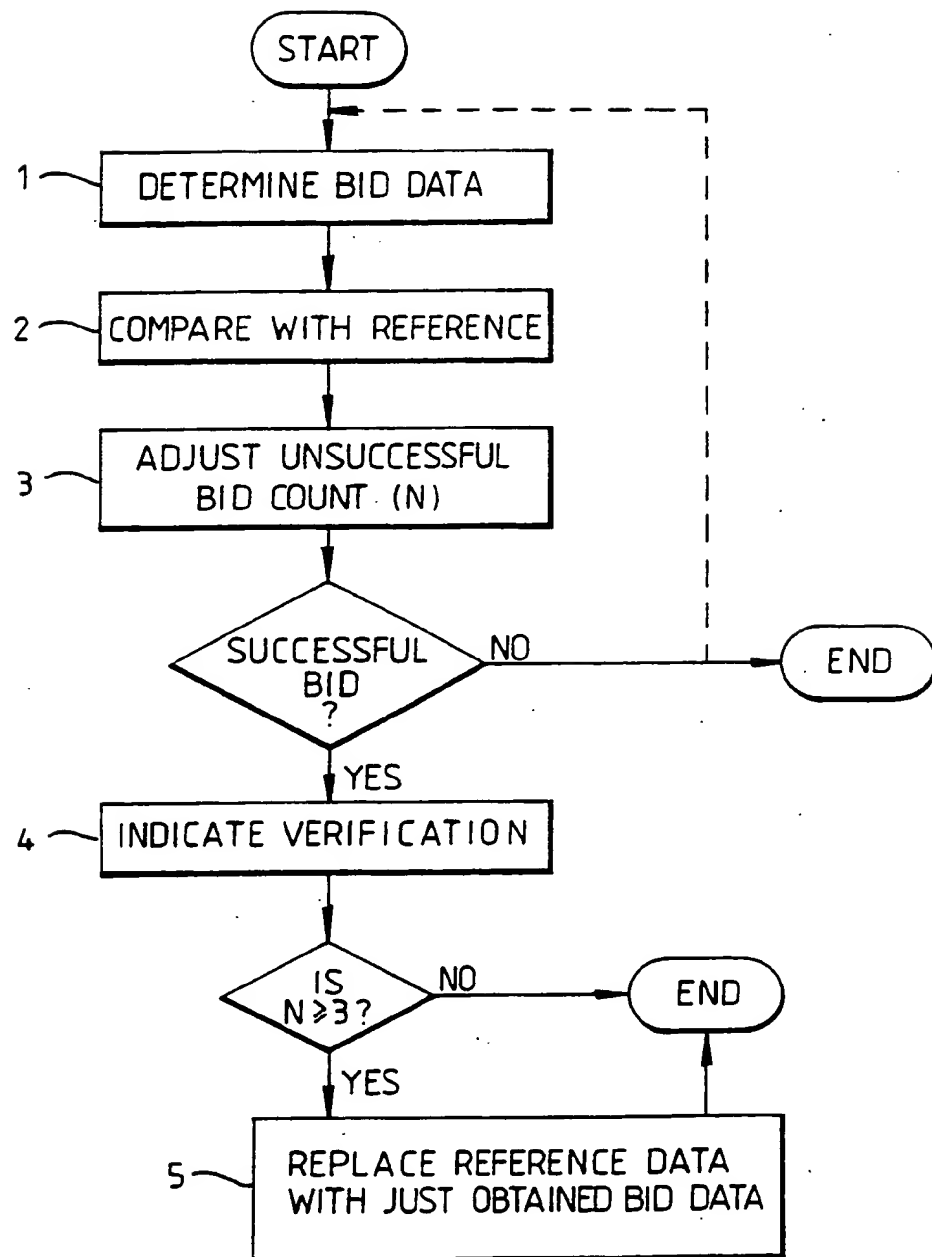


CLAIMS

1. A method of updating reference biometric data characteristic of an individual for use in a verification or authentication process in which process the relationship  
5 between the currently measured biometric data and the reference biometric data is determined, the method comprising monitoring the acceptability of the relationship determined during a number of verification or authentication processes; and if a number N of the  
10 relationships over a number M of verification or authentication processes is unacceptable, updating the reference biometric data with more recently obtained biometric data.
2. A method according to claim 1, wherein the more  
15 recently obtained biometric data which is used to update the reference biometric data is selected from biometric data which satisfies predetermined conditions defining a better degree of acceptability than is essential to pass the verification or authentication process.
- 20 3. A method according to claim 2, wherein the most recently obtained measured biometric data which satisfies the predetermined conditions will be used to update the reference biometric data.
4. A method according to any of the preceeding claims,  
25 wherein N is at least 3 and M is 8.
5. A method according to any of the preceeding claims, further comprising monitoring the performance of the user and providing an indication that reenrolment is advisable if the performance of the updating method satisfies  
30 predetermined conditions.
6. A method according to claim 5, wherein the predetermined conditions comprise the detection of at least P consecutive unacceptable relationships, or the performance of at least Q updating steps within R  
35 performances of the verification or authentication process.
7. A method according to claim 6, wherein P is 4, Q is 3 and R is 32.

8. A method according to any of the preceeding claims, wherein the biometric data define a fingerprint.

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# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 90/01830

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5                      G07C9/00 ;      G06K9/20		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	G07C ;              A61B ;              G06K ;              G07D	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
A	IBM TECHNICAL DISCLOSURE BULLETIN. vol. 21, no. 1, June 1978, NEW YORK US pages 424 - 425; ANTHONY e.a.: "Supervised adaption for signature verification system" see the whole document ---	1-3
A	US,A,4451929 (YOSHIDA) 29 May 1984 see column 1, line 41 - column 3, line 21 see column 4, lines 17 - 55; figures ---	1-3
A	US,A,4724542 (WILLIFORD) 09 February 1988 see abstract; claims 1-8; figures ---	1-3
A	GB,A,2087548 (OMRON TATEISI) 26 May 1982 see abstract; claims 1-9; figures --- <div style="text-align: center;">-/-</div>	1
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>10</sup> Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
28 FEBRUARY 1991	19.03.91	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	MEYL D.	

Form PCT/ISA/210 (second sheet) (January 1985)

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**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
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